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January 19, 1995

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

William F. Caton
Acting Secretary
Federal Communications Commission
Room 222
1919 M Street, N.W.
Washington D.C. 20054

In Re: **Ex Parte Presentation in PR Docket No. 92-235 (Replacement of Part 90 by Part 88 to Revise the Private Land Mobile Radio Services)**

Dear Mr. Caton:

On January 19, 1995, Ron Marwitz and Nick Gorham of Motorola, Inc. and myself met with Ron Netro, Herb Zeiler, Kathryn Hosford, Eugene Thompson and Ira Keltz of the Wireless Telecommunications Bureau on issues related to the above captioned proceeding. In particular, the representatives from Motorola discussed the various factors that affect adjacent channel interference protection for land mobile stations operating at either 25 kHz, 12.5 kHz or 6.25 kHz apart. In this regard, Motorola indicated its support for the technical comments submitted by the Telecommunications Industry Association during earlier phases of this proceeding. In addition, the following hand-outs were distributed to the staff and should be associated with PR Docket No. 92-235.

Please call me at (202) 429-7338 should you have any questions on this matter.

Sincerely,

Michael A. Lewis

Michael A. Lewis
Engineering Policy Advisor
Wiley, Rein & Fielding
Counsel to Motorola, Inc.

c.c.
Kathryn Hosford

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List A B C D E

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1/19/95

Adjacent Channel Interference Protection Ratio

VHF - 15/7.5 KHz Channel Plan

Adjacent Channel Equipment	Channel Separation 15 KHz	Channel Separation 7.5 KHz
25 KHz into 25 KHz	30 db	
25 KHz into 12.5 KHz	50 db	
12.5 KHz into 25 KHz	50 db	
12.5 KHz into 12.5 KHz	60 db	20 db
25 KHz into 6.25 KHz	50 db	
6.25 KHz into 25 KHz	60 db	
6.25 KHz into 12.5 KHz	60 db	40 db
12.5 KHz into 6.25 KHz		20 db
6.5 KHz into 6.25 KHz		60 db

Refarming
Private Land Mobile
150 - 174 MHz

	ACIPR
25 KHz Equipment - 15 KHz Channel Spacing	27 - 30 db
12.5 KHz Equipment - 7.5 KHz Channel Spacing	18 - 20 db
Net Decrease	9 - 12 db

Urban/Suburban/Open - Flat Terrain

160 MHz - Mobile Antenna Height 5 Ft.

Base Height	Additional Path Length*	Additional Path Loss
150 Ft.	6 Miles	8.5 db
300 Ft.	8 Miles	10.0 db
150 Ft.	8 Miles	11.1 db
150 Ft.	10 Miles	13.5 db

*Baseline Path Length - 10 Miles

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Adjacent Channel Interference Protection Ratio

UHF - 25/12.5/6.25 KHz Channel Plan

	Channel Separation		
Adjacent Channel Equipment	25 KHz	12.5 KHz	6.25 KHz
25 KHz into 25 KHz	70 db	12 db	
25 KHz into 12.5 KHz		35 db	
12.5 KHz into 25 KHz		35 db	
12.5 KHz into 12.5 KHz		60 db	
6.25 KHz into 25 KHz		40 db	
25 KHz into 6.25 KHz		35 db	
6.25 KHz into 12.5 KHz		60 db	
12.5 KHz into 6.25 KHz		60 db	
6.25 KHz into 6.25 KHz			60 db
(1/2 Channel Offset)		9.375	
6.25 KHz into 12.5 KHz		60 db	
12.5 KHz into 6.25 KHz		35 db	

Business Radio Service Channel Usage
Repeater Channels vs. Offset Channels
(1992)

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	105 UHF Rptr Pairs		130 Offset Pairs	
City (75 MIRA)*	# Mbls	Mbls/Pair	# Mbls	Mbls/Pair
New York	76,386	727.48	93,299	717.68
Los Angeles	68,992	657.06	121,501	934.62
Dallas	30,891	198.96	44,075	339.03
Miami	24,454	232.89	16,619	127.83
Minneapolis	19,980	190.28	33,644	258.80
Raleigh	19,257	183.40	13,540	104.15
Omaha	12,814	122.03	4,586	35.27

* 75 Mile Radius of Urban Center

Offset Channel Use
Public Safety Services
450-470 MHz
(1992)

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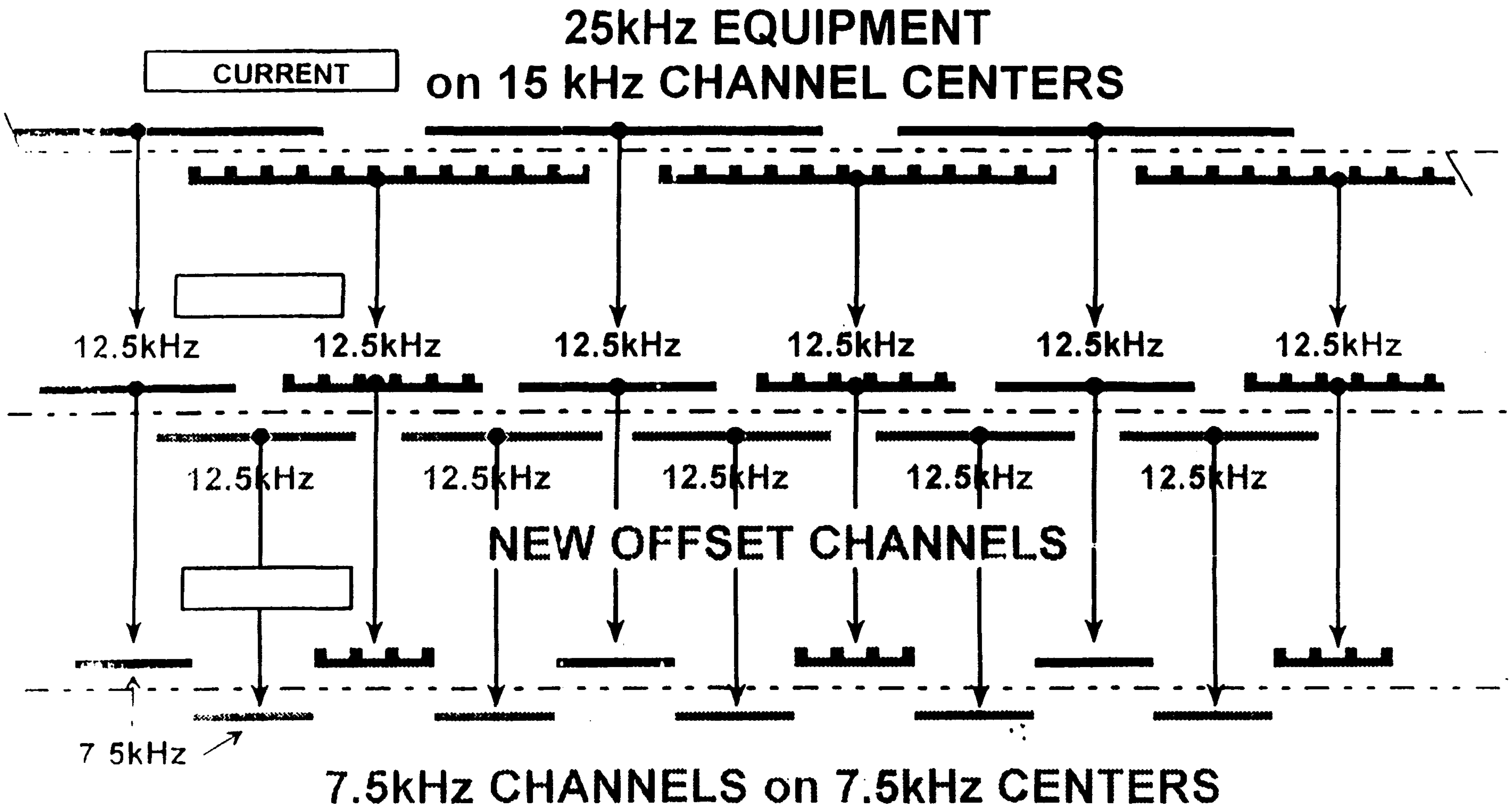
The following is an analysis of the low power offset channel usage in the 450-470 MHz band in three markets: New York, Chicago, and Los Angeles. This analysis covers the Public Safety Radio Services. The Public Safety Radio Servicers include Fire (PF), Highway Maintenance (PH), Local Government (PL), Forestry-conservation (PO), Police (PP), and Special Emergency (PS) services.

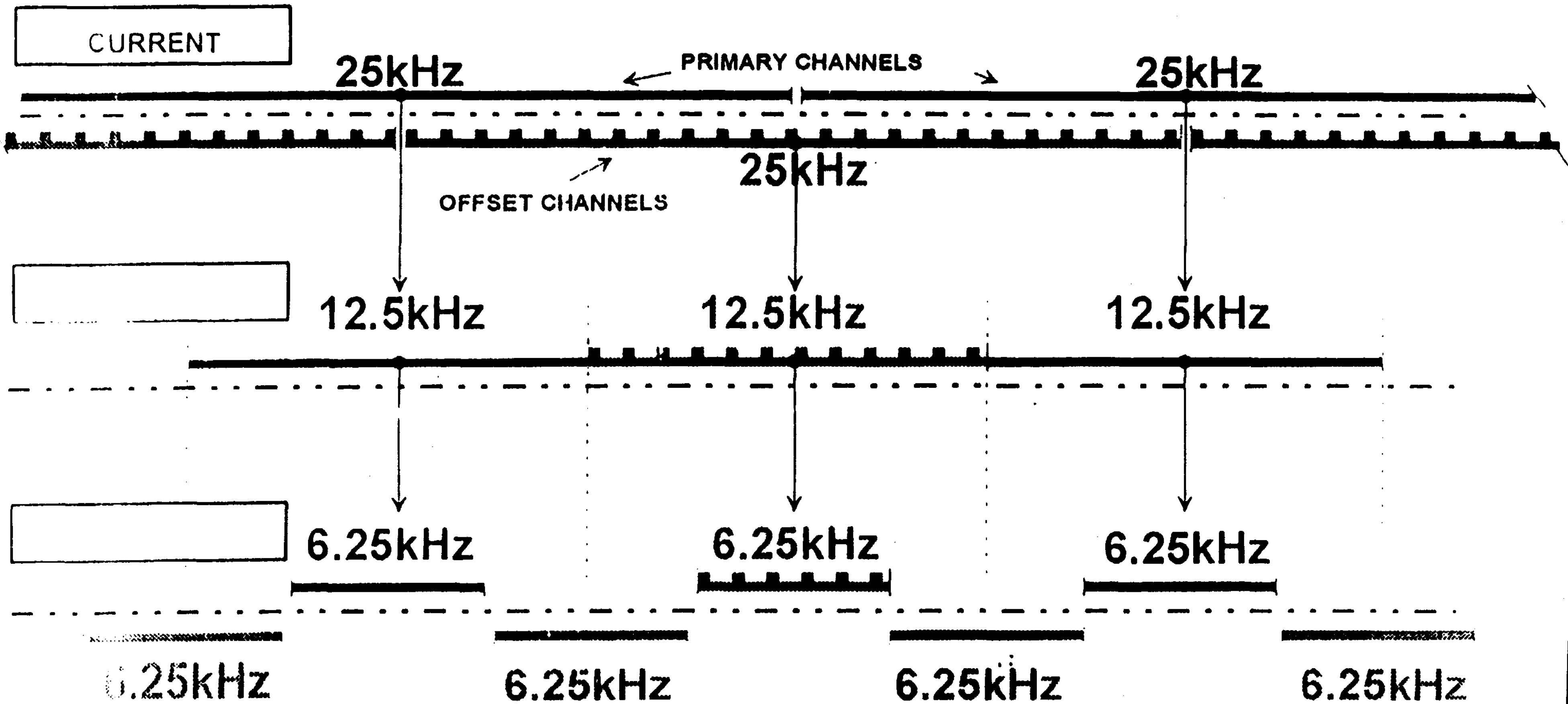
	Total Offset Chan'ls Available	New York		Chicago		Los Angeles	
		# of Offsets In Use	% of Available Offsets	# of Offsets In Use	% of Available Offsets	# of Offsets In Use	% of Available Offsets
453.xxx5	39	35	89.7	22	56.4	20	51.3
458.xxx5	39	38	97.4	18	46.2	17	43.6
460.xxx5	24	23	95.8	5	20.8	1	4.2
465.xxx5	24	23	95.8	9	37.5	3	12.5
462/463 .xxx5	9	5	55.6	1	11.1	8	88.9
467/468 .xxx5	9	3	33.3	1	11.1	8	88.9
Totals	144	127	88.2	56	38.9	57	39.6

VHF Migration

AAR Offset Overlay
VNB = 7.5kHz

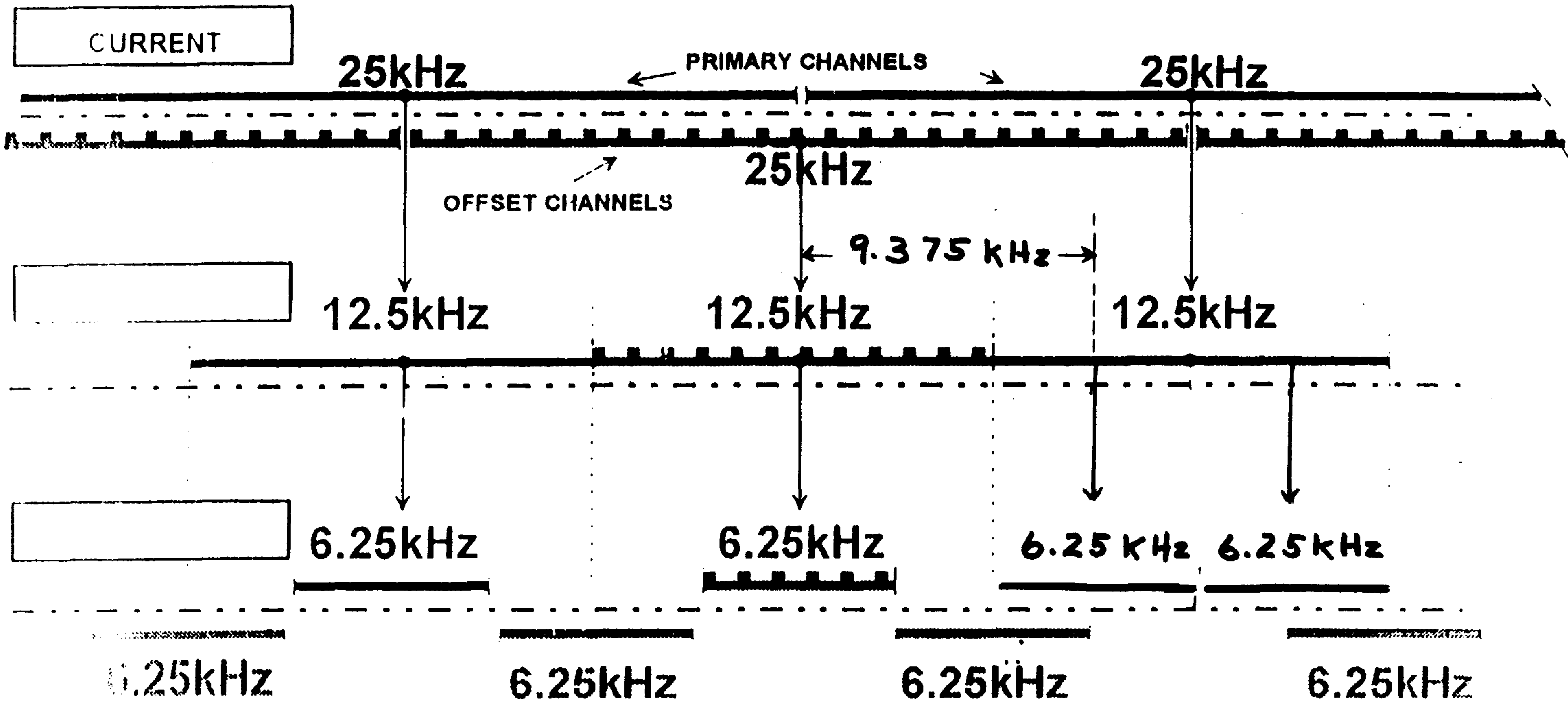


UHF Migration
VNB = 6.25kHz
AAR and LMCC



NEW 6.25 kHz CHANNELS

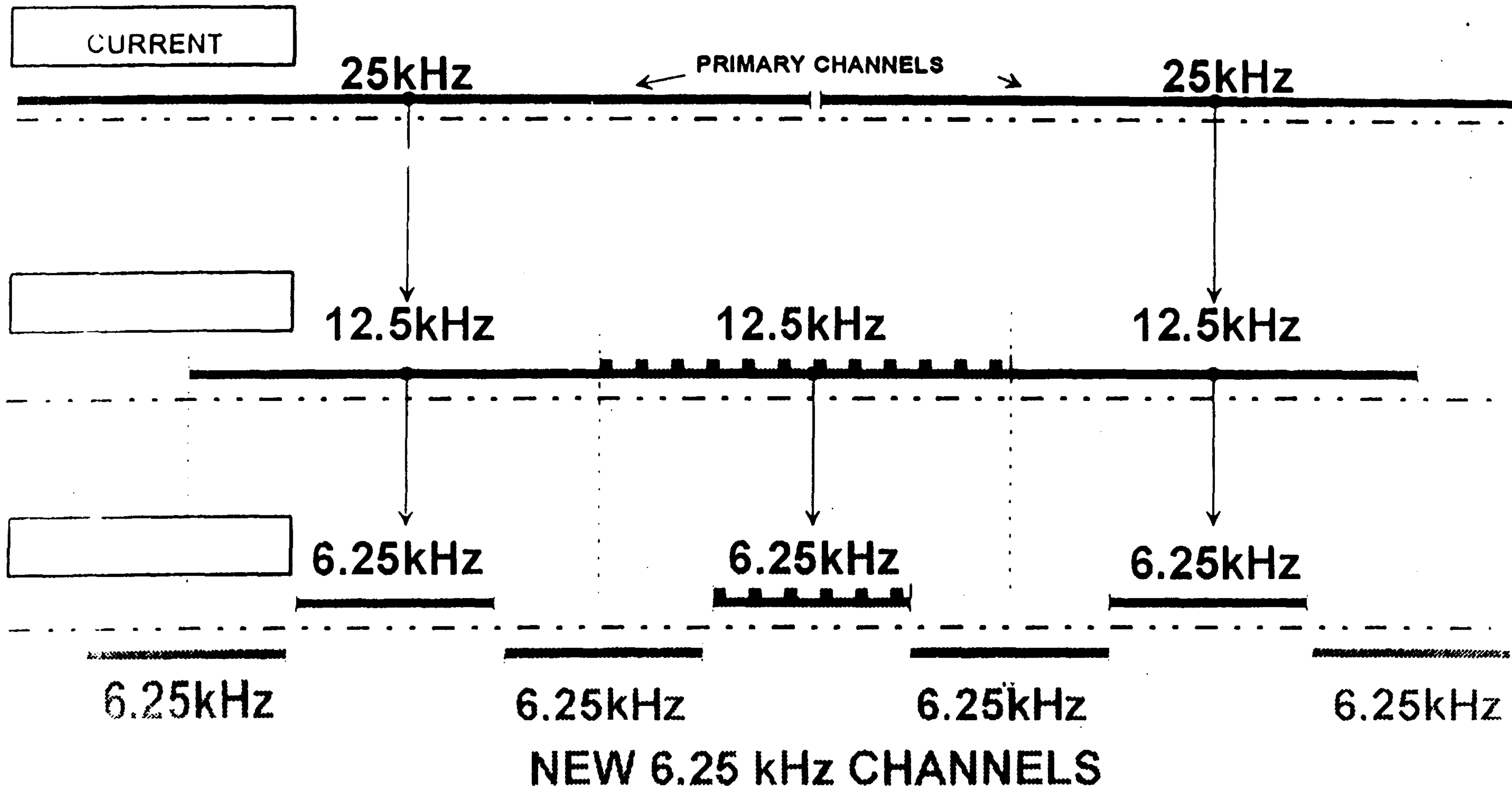
UHF Migration
VNB = 6.25kHz
AAR and LMCC



NEW 6.25 kHz CHANNELS

UHF Migration
VNB = 6.25kHz

AAR and LMCC
470 to 512 MHz



APPENDIX B

TIA PROPOSED EMISSIONS MASKS

A. 12.5 kHz Mask

This 12.5 kHz mask is intended for:

- reduced deviation analog (*i.e.*, 2.5 kHz peak deviation with a splatter filter similar to that used for 896-901 MHz equipment), or
- advanced digital FDMA modulation using QPSK-c modulations as proposed for use within APCO Project 25 (using either the FM version, C4FM, or the partially linear version, CQPSK).

Based on actual equipment measurements and computer simulations, TIA has developed a proposal for the 12.5 kHz masks. The 12.5 kHz mask is as follows:

Displacement Frequency (f)	Attenuation (Db)
$0 < f \leq 2.5$ kHz	0
2.5 kHz $< f \leq$ 12.5 kHz	7(f-2.5)
12.5 kHz $< f$	50 + 10 log(P) or 70 dB, whichever is the lesser attenuation

This mask has been designed to use a spectrum analyzer with the following settings:

- Resolution Bandwidth (BW) = 300 Hz. (This choice of bandwidth is critical because it has been chosen to equalize the spectrum of tones, which is relatively fixed as the analyzer bandwidth changes, to that of the noise-like advance digital or other digital signals which will move up as BW is increased and down as BW is decreased).
- Video Bandwidth $\geq$ 3000 Hz
- Span = 50 kHz for 12.5 kHz channels
- For noise-like or digital signals, peak hold should be utilized with at least 10 sweeps.
- A sweep speed which allows the analyzer to remain calibrated should be used.

With the center frequency of the analyzer set to the assigned transmitter frequency, the transmitter should be keyed with an unmodulated carrier, and the level adjusted to the full scale reference line. This is the 0 dB reference for the measurement. For analog modulation, modulate the transmitter with a 2.5 kHz overdriven tone (with the level set 16 dB higher than that required to achieve 1.25 kHz deviation, 50% of rated system deviation). For digital modulation it is assumed that the vocoder technique will cause the modulated signal to be essentially random so that no special input need be applied.

For digital voice modulation, the FCC spectrum designator when using C4FM is 8K1F1E. The first 3 characters show that this emission has a 99% power bandwidth (occupied bandwidth) of 8.1 kHz. The 4th character stands for frequency modulation. The 5th character describes the nature of the signal as being modulation of the main carrier. And the 6th and last character signifies that it is a telephony or voice transmission.

B. 6.25 kHz Mask

This mask has been developed in support of APCO Project 25. While Project 25 is concerned only with digital modulation, the emission masks described are intended for both analog and digital modulation. Because FM modulation cannot be supported in 6.25 kHz channels, this proposed masks allows either Single Side Band (SSB) modulation for the analog case or can be used with the proposed digital modulation for APCO Project 25 using the compatible CQPSK modulation method. The plan is to allow voluntary migration to 6.25 kHz channels using this mask.

Displacement Frequency (f)	Attenuation (Db)
$0 < f \leq 3$ kHz	0
3 kHz $< f \leq$ 4.6 kHz	30 + 16.67(f-3.0) or 55 + 10 log(P) or 65 dB, whichever is the lesser attenuation
4.6 kHz $< f$	55 + 10 log(P) or 65 dB, whichever is the lesser attenuation

The mask has been designed to use a spectrum analyzer with the following settings:

- Resolution Bandwidth (BW) = 100 Hz
- Video Bandwidth $\geq$ 100 Hz
- For noise-like or digital signals, peak hold should be utilized with at least 10 sweeps.

- A sweep speed which allows the analyzer to remain calibrated should be used.

The new TIA technique of using a very wide IF setting should be used to set the reference level at 0 dB. For the analog case, the transmitter should be modulated with the input signal specified by pervious rules for the 200 MHz band. For digital modulation it is assumed that the vocoder technique will cause the modulated signal to be essentially random so that no special input need be applied.

The above mask is based on the 220 MHz mask already developed for SSB modulation and the proposed FCC masks for 6.25 kHz channels. The only thing that has been done is to extend the authorized bandwidth from 5 kHz to 6 kHz. This was necessary because the bandwidth of the 9600 bps CQPSK signal is ideally 5.76 kHz. The extension of this to 6 kHz was done to accommodate the resolution bandwidth of the spectrum analyzer.

APPENDIX C

FREQUENCY STABILITY

I. FIXED AND BASE STATIONS (PARTS PER MILLION)

FREQUENCY BAND	25 kHz	12.5 kHz	6.25 kHz
150 - 222 MHz	5.0	2.5	1.0
450 - 512 MHz	2.5	2.0[1]	0.1

II. MOBILE STATIONS (PARTS PER MILLION)

FREQUENCY BAND	25 kHz	12.5 kHz	6.25 kHz
150 - 222 MHz	5.0[2]	5.0	1.0
450 - 512 MHz	5.0	2.5	0.5

[1] Beginning January 1, 1996, fixed and base stations must have a frequency stability of 1.5 ppm.

[2] Mobile stations operating at 2 watts or less power output may operate at a frequency stability of 50 ppm.

ADJACENT CHANNEL INTERFERENCE CONSIDERATIONS IN NARROWBAND FM RADIO SYSTEMS

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Communication Systems Research Laboratory
Motorola, Inc.
Schaumburg, Illinois

Abstract-The demand for land mobile radio service has exceed the current supply of spectrum in the major metropolitan areas. This led the FCC to legislate 12.5kHz channels in the recently allocated 900MHz band, a 2:1 reduction in channel spacing compared with land mobile channels in the UHF and 900MHz bands. While this splitting helps to relieve the spectrum congestion in the channel starved markets, the reduced channel spacing also leads to a reduction of the guard band between channels, and thereby the potential for reduced coverage due to increased adjacent channel splatter. This paper reviews the origin and magnitude of transmitter splatter in FM radios, and how it is measured. The various ways it can affect system performance will be discussed. Some hardware design and operational methods to limit the potential interference from this cause will be presented, together with an estimate of their effectiveness.

I. INTRODUCTION

The demand for land mobile radio service has exceeded the allocated spectrum in the major metropolitan areas. A number of approaches to relieving the spectrum congestion of mobile communication have been pursued in the past. These have included allocation of new bands, increased sharing between services, trunking, and channel splitting. Of these, channel splitting has often been invoked due to its easily perceived benefits in terms of spectrum efficiency improvement and apparent simplicity.

There is a practical limit, however, to the extent channel splitting can be employed before some change in basic system technology is required. This limit is due primarily to an increased probability of adjacent channel interference which occurs as the bandwidths of the guard bands between channels are reduced [1-3].

This paper will discuss the effects of adjacent channel interference on system performance. Also described are the origins of, methods to measure, and methods to mitigate adjacent channel interference. Since the FCC has recently allocated spectrum to the land mobile radio service at 896MHz which will employ 12.5kHz channels, the narrowest land mobile FM channels yet employed, the examples given in this paper will relate to 12.5kHz channels. As will be seen, further subdivision of FM channels is not practical without major system modification.

II. ORIGIN OF ADJACENT CHANNEL INTERFERENCE

The origin of adjacent channel interference is shown in Figure 1. The figure shows two transmissions occurring on adjacent channels. Due to the nature of frequency

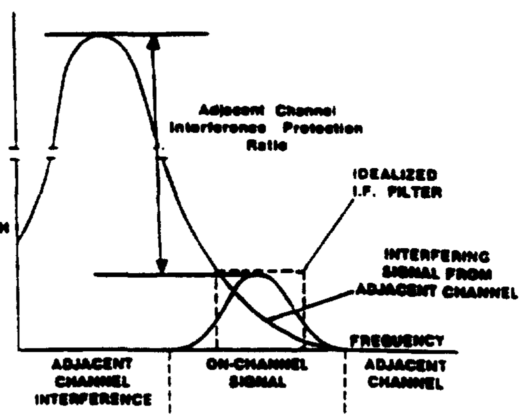

FIG.1 Origin of adjacent channel interference.

modulation, the finite attenuation of splatter filters, and oscillator noise, the frequency spectra of the transmissions extend beyond the channel boundaries. Some of the power is intercepted by the adjacent channel receiver. When the signal strength of the adjacent channel transmission becomes so large that the power intercepted by the on-channel receiver approaches the signal strength of the on-channel transmission, interference occurs.

The ratio of the signal strengths of the two transmissions at the point at which interference occurs is called the adjacent channel interference protection ratio, or ACIPR. An ACIPR of 70dB or greater has historically been considered a good value for land mobile systems [4]. This means that the signal strength of the adjacent channel must exceed the signal strength of the on-channel signal by 70dB before interference will result.

The reason adjacent channel interference is worse at the 12.5kHz channel spacing than at the 25kHz channel spacing, even though the deviation has been reduced from 5kHz to 2.5kHz, is demonstrated in Figure 2. This figure shows a plot of the bandwidth required to contain all but -70dB of the transmitted power on each side as a function of deviation for baseband bandwidths of 1.5kHz and 3kHz.

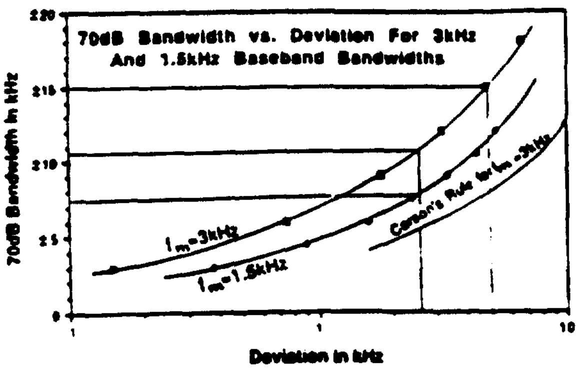

Fig. 2. Modulation bandwidth vs. deviation and audio bandwidth.

It can be seen from the 3kHz line that reducing deviation from 5kHz to 2.5kHz reduces the 70dB bandwidth by only a factor of 0.7 rather than 0.5. Reducing the deviation to 2.5kHz and the baseband bandwidth to 1.5kHz reduces the 70dB bandwidth to 7.5kHz, which is 0.5 times the original bandwidth. This shows that baseband bandwidth must be scaled along with deviation in order to scale transmitter bandwidth, and therefore transmitter splatter. This is not possible without unacceptable degradation in audio quality.

The Carson's Rule bandwidth is also shown for 3kHz baseband bandwidth. As is easily seen, Carson's Rule cannot be used to determine channel spacing in an FM system, since it completely ignores the issue of adjacent channel interference performance.

Note that the graph indicates that 70dB bandwidth can be continuously reduced by reducing the deviation. However, this is not a practical means for reducing the splatter for narrow spaced FM channels, as will be shown next.

Figure 3 shows the effects of reduced deviation on sensitivity. The shaded bars are measured 12dB SINAD sensitivities determined at various deviations using a typical 800MHz receiver. Sensitivity is given with respect to the nominal EIA sen-

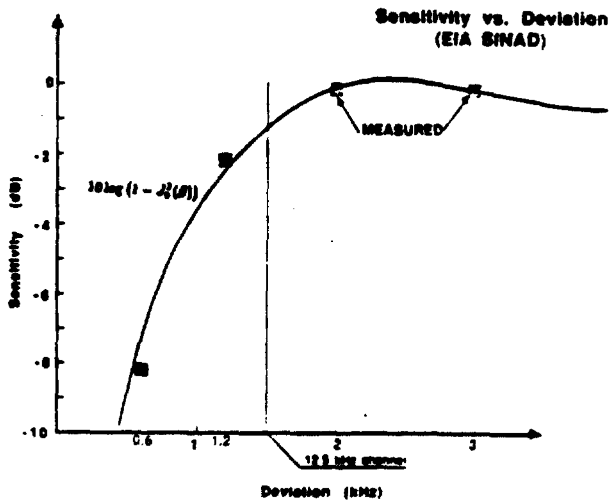

Fig. 3. EIA SINAD sensitivity vs. deviation.

sitivity conditions of 1kHz tone at 60% rated deviation [5]. Note that as the deviation is reduced from 3kHz to 2kHz, sensitivity does not degrade measurably. However, below 2kHz the sensitivity degrades quite rapidly. This characteristic correlates well with the level of power in the modulation sidebands, which is shown by the solid line. This shows that sensitivity is independent of deviation for deviations above approximately 2kHz, while below 2kHz, sensitivity is a strong function of deviation.

The deviation level used for sensitivity measurement of a 12.5kHz channel system is shown. It is past the knee of the curve, and deviation reduction will degrade sensitivity immediately, and rapidly.

For 12.5kHz channel systems, the small sensitivity degradation from reduced deviation is more than offset by the narrowing of the receiver IF bandwidth. If channel spacing is reduced further in the future, this sensitivity degradation will become significant.

Figure 4 is a history of the adjacent channel interference performance and sensitivity of land mobile radio systems as channel spacing has been reduced from over 100kHz to today's 12.5kHz, and beyond. The graph has been adjusted to employ the technology used in modern 800MHz synthesized radios so that trends can be noted, rather than the parameters of specific radios used at specific bands.

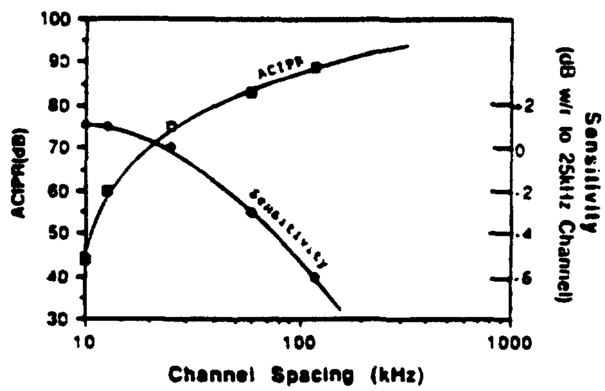

Fig. 4. History of land mobile sensitivity and adjacent channel interference performance.

Note first the ACIPR performance. In systems with channel spacings of greater than 20kHz, ACIPR is limited by sideband noise, and increases slowly as channel size increases. As channel size approaches 12.5kHz, ACIPR becomes limited by transmitter splatter, and degrades rapidly with with decreasing channel spacing.

Note also that with decreasing channel size, sensitivity has increased, improving coverage, until the increase levels off near 12.5kHz. The trend to note is that coverage improvement due to reduced IF bandwidth disappears at the same time that coverage penalties due to adjacent channel interference begin.

Figure 4 shows that another reason adjacent channel interference is a bigger problem at 12.5kHz channel spacing is that the variation of ACIPR with frequency offset is worse. At wider channel spacings ACIPR is limited by sideband noise and varies at approximately 6dB per octave of frequency for synthesized radios. At the 12.5kHz spacing ACIPR is limited by transmitter splatter and varies approximately 8dB/kHz.

For example, the 4ppm frequency tolerance specified for today's 800MHz systems allows a worst case frequency offset of about 3.5kHz. At 6dB per octave, the ACIPR would degrade less than 2dB. A similar frequency offset in a 12.5kHz channel system would degrade ACIPR by approximately 28dB. Clearly, an improvement in frequency stability is essential.

The system stability specified for the new 896MHz band is 1.6ppm. The mobile part of this is 1.5ppm, which is considered the highest tolerance practical for use in a mobile today. The base tolerance is 0.1ppm, since size and cost are not as critical at the base. Even so, the ACIPR is degraded by nearly 12dB.

III. EFFECTS OF INTERFERENCE

Degraded splatter protection can lead to degraded system coverage effects for both talk-out and talk-in.

The talk-out case is illustrated in Figure 5, which shows a mobile located between two transmitter sites designated A and B, and assumed to be on adjacent channels. The large circle represents the coverage provided by the transmitter at site A, in the absence of interference transmitter B. However, with transmitter B included, there is a region around B where the signal

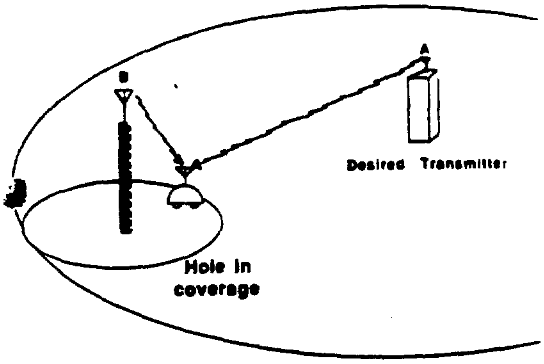

Fig. 5. Impact of adjacent channel interference on talk-out coverage

strength from transmitter B is large enough to meet or exceed the ACIPR for the mobile in system A, leading to a hole in the coverage as depicted by the smaller circle. The size of the hole in practice will depend on a combination of the local geography, the specific geometry of the situation, the transmitter power levels, and the ACIPR value [6]. However, providing the ACIPR is above some minimum value necessary to compensate for independent Rayleigh fading, and some minor shadowing differences, the hole in the coverage for talk-out essentially disappears if the two transmitters are co-located. Thus, where multi-channel systems are involved, it can be advantageous to use contiguous channel assignments for this reason.

The degradation in in-bound coverage due to degraded splatter protection is shown in Figure 6. In this case the problem occurs when a second mobile on an adjacent channel,

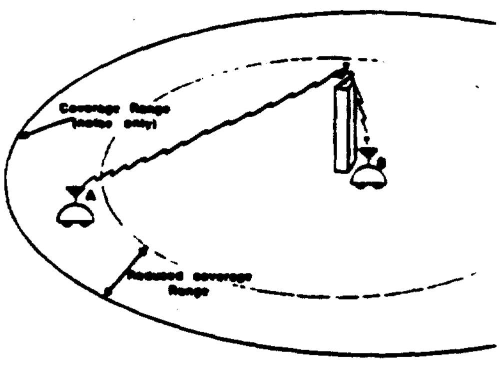

Fig. 6. Impact of adjacent channel interference on talk-in coverage.

mobile B in the figure, is close to mobile A's base receiver. Again, depending on the specifics, the coverage range for A is reduced when mobile B transmits and its signal at the base site exceeds the ACIPR for the system [7]. Note that contiguous channel assignments does not help directly in this case.

IV. MEASUREMENT METHODS

The ACIPR of a system can be measured in several ways. The important point is to obtain a value that accurately represents what a user will experience, and some tests are better at that than others.

The simplest measurement is the EIA Standard RS-204-C receiver selectivity measurement using 1kHz and 400Hz tones at 60% rated deviation on the desired and interfering channels, respectively. This measurement is simple to make, repeatable, and easy to model mathematically. However, while useful as a measure of selectivity, the measurement is not a meaningful measure of ACIPR. Since voice can cause high frequency, high deviation peaks, the use of a 400Hz tone at 60% rated deviation gives optimistic results in cases where ACIPR is splatter limited, such as in 12.5kHz channel systems.

A method that provides a more useful result involves a subjective measurement, wherein a number of test subjects are asked to listen to voice transmission on a radio setup and adjust the signal strength of an interfering voice transmission until they feel an interference criterion has been met. At this point, the ratio of the signal strengths of the two transmissions is the ACIPR. The voice transmissions are filtered and deviation controlled just as they would be under normal operating conditions in the equipment under test. Typical interference criteria are a level of interference which is "just noticeable" and a level of interference which "hurts intelligibility".

Although the magnitude of the result depends on the criterion employed, results in our lab have shown that the rate of degradation is quite rapid. For example, between "just noticeable" and "hurts intelligibility" represents about 6dB increase in ACIPR. Thus this method can provide a useful basis for comparison even where the criteria values are not objectively determinable.

An alternate method which is more objective in nature and retains the use of voice as the interferer is SINAD degradation [8]. In this method, a 1kHz tone at 60% rated deviation is used on the desired channel and a 12dB SINAD condition is set up. Adjacent channel signal strength is increased until SINAD is degraded to 6dB on voice peaks. At this point, the ratio of the signal strengths of the two transmissions is the ACIPR. Experience has shown that ACIPR values determined using this method lie about midway between those determined using the "just noticeable" and "hurts intelligibility" criteria described above.

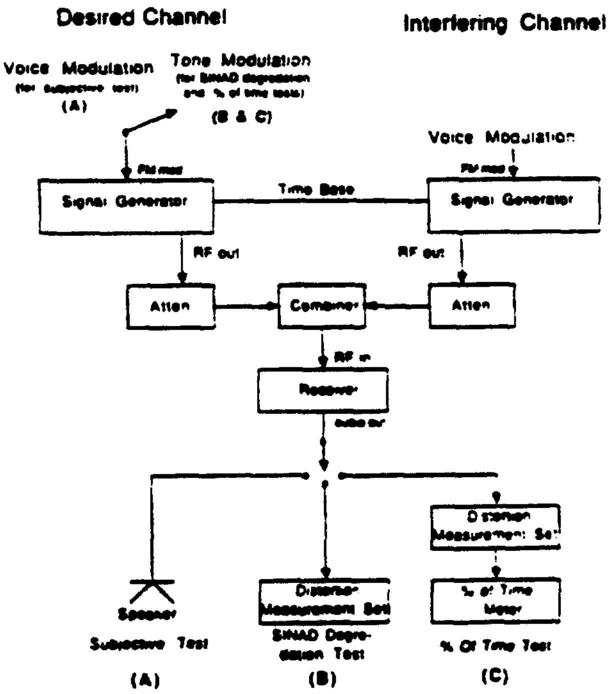

Fig. 7 Test equipment configurations for (A)subjective test, (B)SINAD degradation, (C)measured % of time.

The advantages of this method are that listeners are not needed, results are quickly available, the measurement is quite repeatable, and it gives a meaningful result. The disadvantage is that some subjectivity is required in determining when voice peaks are degrading SINAD to 6dB.

A variant on the above removes the remaining subjectivity by using the percent of time a voice transmission degrades a 12dB SINAD condition below a given SINAD level [9]. This measurement is performed iteratively, adjusting the strength of the interfering signal, and measuring the percent of time SINAD is degraded below different SINAD levels over an approximately 30 second period until the percent of time below a given SINAD is some fraction of the time. For example, a criterion of 12dB SINAD degraded to 8dB for 20% of the time yields a measured ACIPR value close to that for "hurts intelligibility".

Figure 7 shows the test equipment configurations used for the measurement methods described above.

V. MEASUREMENT RESULTS

Measurements of ACIPR were made, as a function of frequency offset, for several values of audio bandwidth and deviation, using the SINAD degradation method of Figure 7(B). The receiver employed in the measurements had an IF bandwidth of 8.1kHz at the 6dB points, which is somewhat wider than will be used in the new 900MHz radios but representative of those used at high band where stability problems are less severe. The results are shown in Figure 8 for adjacent channel frequency offsets ranging from 7.5kHz to 12.5kHz. Curves for four combinations of audio bandwidth and deviation are plotted. As indicated, the lowest curve represents the splatter results which were obtained using the same 3kHz audio bandwidth as employed in 800MHz radios, but reducing the peak deviation to 2.5kHz. Note that the best ACIPR in this case is only 52dB at 12.5kHz offset, far from adequate for nominal system usage. The upper curve

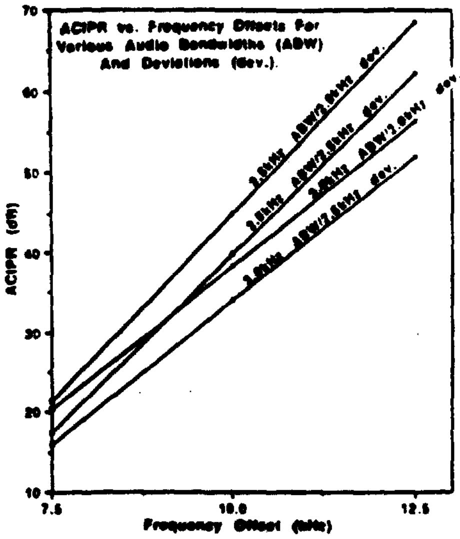

Fig. 6. ACIPR vs. frequency offset for various audio bandwidth (ABW) and deviations (dev.).

represents the other extreme of measured parameters and shows that even for 2.5kHz audio bandwidth and 2.0kHz deviation, the ACIPR only approaches the needed value for offsets close to 12.5kHz. It follows that without some major system change, such as digital speech encoding to reduce audio bandwidth still further, channel spacing below 12.5kHz will not be possible without severely reduced performance. Even at 12.5kHz it is clear that some changes are necessary to ensure systems with comparable coverage and audio quality to those at 800MHz. Examples of possible changes are given in the next section.

VI. *INTERFERENCE MITIGATION METHODS*

As indicated earlier, there are several ways to reduce or eliminate the deleterious effects of increased adjacent channel splatter. These include the co-siting of adjacent channel transmitters where possible, increasing the inherent system frequency stability, and keeping the receiver IF as narrow as possible consistent with that needed for adequate signal recovery.

Still further benefit can be provided by increasing the skirt roll-off of the transmitter audio splatter filter. For example, increasing the number of poles from three (18dB/octave) as used in 25kHz spaced radios, to five poles (30dB/octave), a gain of about 6dB in ACIPR has been measured for 12.5kHz radios. However, increasing the number of poles beyond five does not help appreciably.

Beyond the above steps, it becomes necessary to limit the actual power being splattered by an adjacent channel. This is practical where control of the adjacent channels exists. Such a situation exists, for example, for all but the two edge channels of a contiguous block of three of more channels. Even the two edge channels have only one adjacent channel that is not part of the same system. Under this circumstance, it becomes possible to limit adaptively both the maximum power level and deviation of the signals arriving at the receiving site. For example, if the transmitter power from every mobile is controlled so that the signal levels at the base receivers is never more than XdB above threshold sensitivity, where X is 3dB less than the system ACIPR, then interference due to splatter will not occur. This is possible for moderate values of splatter protection, even in a fading environment, since it is only when the adjacent channel signal is very strong, i.e., well above sensitivity, that any power-cut back need be invoked. In fact, under these circumstances it is also practical to reduce the deviation and splatter filter bandwidth by a small amount, gaining considerable improvement in the effective ACIPR. For example, using a combination of 3dB adaptive power reduction, 2dB adaptive deviation reduction, and adaptively dropping the splatter filter corner frequency to 2.5kHz, there is an effective improvement of almost 20dB in ACIPR for 12.5kHz spaced channels. It is important to note that since these cut-backs only occur under strong signal conditions, full system gain, or coverage, is retained, whether there are close in mobiles transmitting on the adjacent channel or not.

VII. CONCLUSION

This paper has shown that adjacent channel interference is a significant obstacle to achieving improvements in spectrum efficiency using today's mobile radio technology. Even at 12.5kHz spacing, significant improvements in stability and system control are necessary to retain performance equivalence with that for 25kHz spaced systems. Further, even with these improvements, it is necessary to provide a high level of frequency planning and coordination, especially for smaller systems. Still further subdivision does not appear to be possible without major changes in system design.

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